



**US Army Corps
of Engineers**
Waterways Experiment
Station

Preliminary Data Summary for July 1995 CERC Field Research Facility

by Clifford Baron, Michael Leffler, Kent Hathaway, Paul Hodges,
William Birkemeier, Brian Scarborough, Ray Townsend

Coastal Engineering Research Center

Approved for Public Release; Distribution is Unlimited

Prepared for Headquarters, U.S. Army Corps of Engineers

July 1995

Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal Engineering Research Center
1261 Duck Road
Duck, NC 27949-4472

Contents

Preface	iv
1— Introduction	1
2— Meteorological Data	7
3— Wave Data	12
4— Current Data	17
5— Visual Observations	20
6— Water Levels	22
7— Bathymetry	24

List of Figures

<u>No.</u>		
1	FRF Location Map	2
2	Month at a Glance	3
3	Instrument Locations at FRF	6
4	Meteorological Monthly Summary	8
5	Wave Heights and Periods	16
6	Water Levels	22
7	CRAB Profiles	24
8	CRAB Profile Envelope	25
9	FRF Bathymetry (14 June 95)	26

List of Tables

<u>No.</u>		
1	Instrument Status/Data Availability	4
2	Gauge Locations	5
3	Meteorological Data	9
4	Wave Data	13
5	Current Meter Data	18
6	Visually Observed Current Data	19
7	Visual Observations	21
8	Water Levels	23

Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

These reports are now available via the World Wide Web at
<http://frf.wes.army.mil/frf.html>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Please send comments to webmaster@duck.wes.army.mil .
If the web is sufficient for your needs and you no longer require hardcopies, please let us know.

1 Introduction

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511 (*baron@duck.wes.army.mil*).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

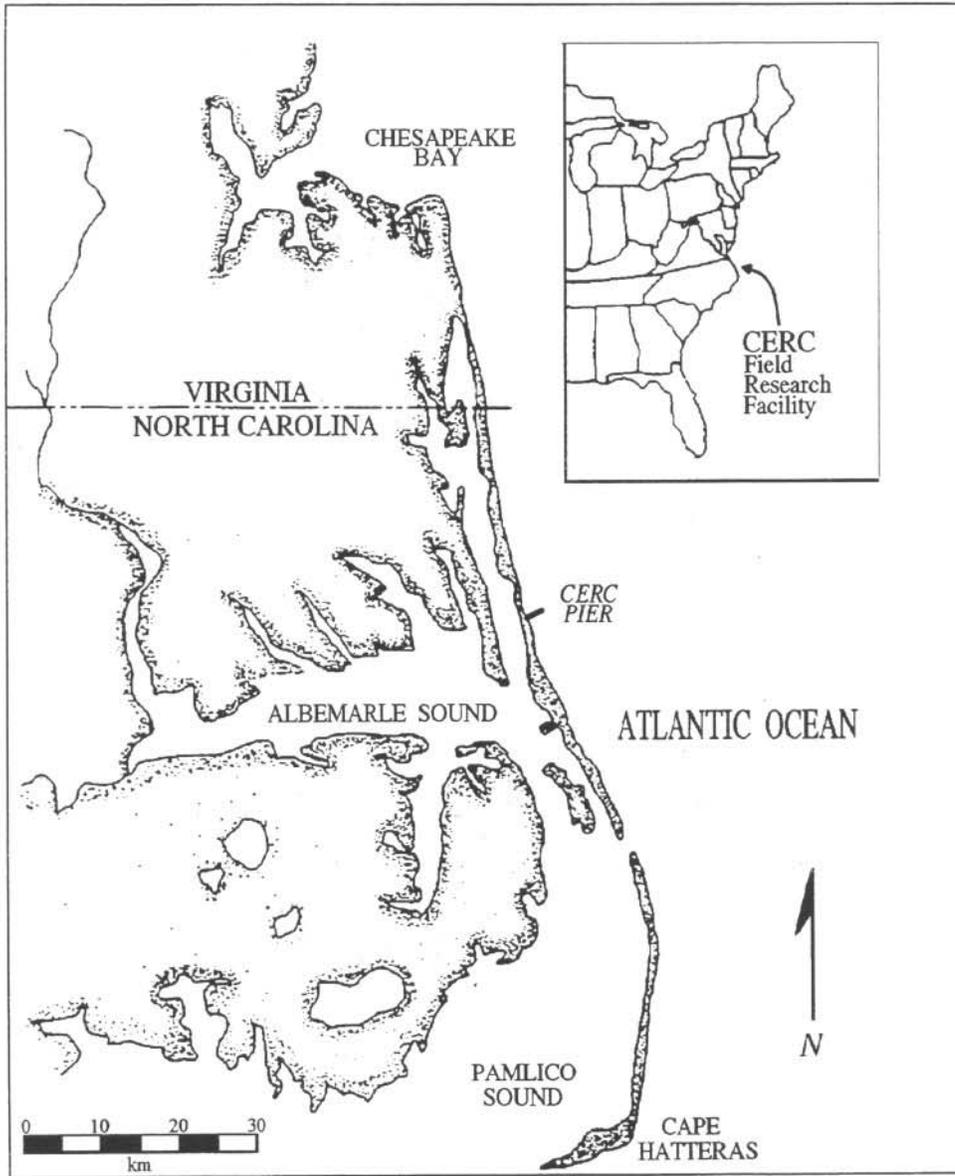


Figure 1. FRF Location Map

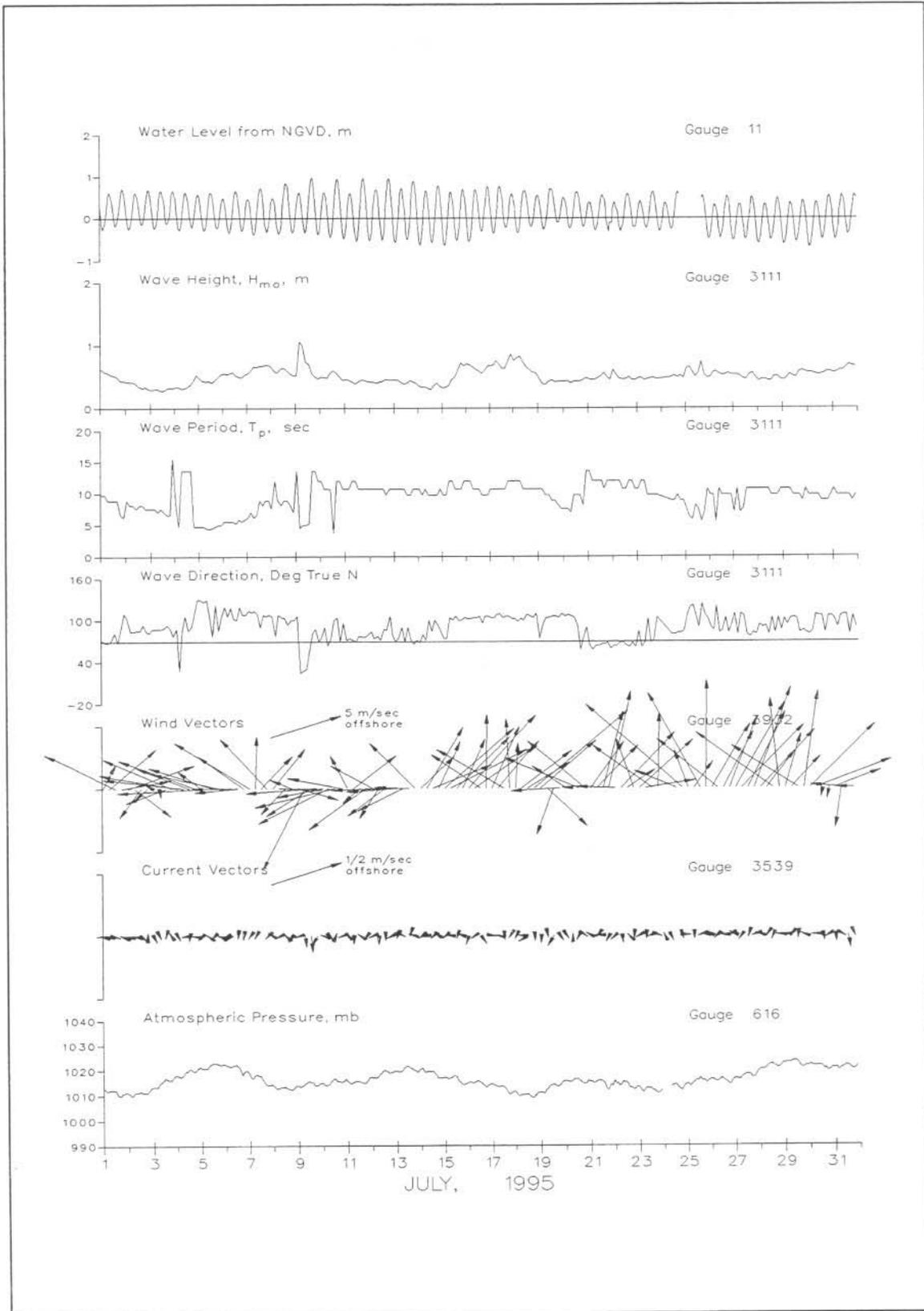


Figure 2. Month at a Glance

**Table 1
Instrument Status/Data Availability**

			July 1995																														
			Day of the month																														
Gauge ID	Description/Remarks		1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3			
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*			
	Visual Observations (daily oceanographic and meteorological observations)	Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			

Gauge Status * = Operational / = Partial - = Non-Operational
 Data Collected * = All / = Partial - = None
 Visual Observations * = Complete / = Partial - = None

**Table 2
Gauge Locations**

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates		Gauge Depth NGVD, m	Water Depth NGVD, m
				Crossshore m	Longshore m		
616	Atmospheric Pressure	36 10' 57.03"	75 45' 5.50"	11.60	569.00	-----	-----
3932	Anemometer	36 11' 1.23"	75 44' 43.07"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10' 57.71"	75 44' 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11' 1.04"	75 44' 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11' 19.14"	75 44' 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11' 11.28"	75 44' 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11' 13.70"	75 44' 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11' 12.48"	75 44' 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11' 14.06"	75 44' 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10' 5.10"	75 41' 59.30"	3934.96	-2400.81	Surface	-17.00
3539	Current Meter	36 11' 23.57"	75 44' 9.12"	1605.80	907.60	-11.60	-11.70
11	NOAA Tide Gauge	36 11' 1.25"	75 44' 42.60"	596.49	514.20	Surface	-7.62

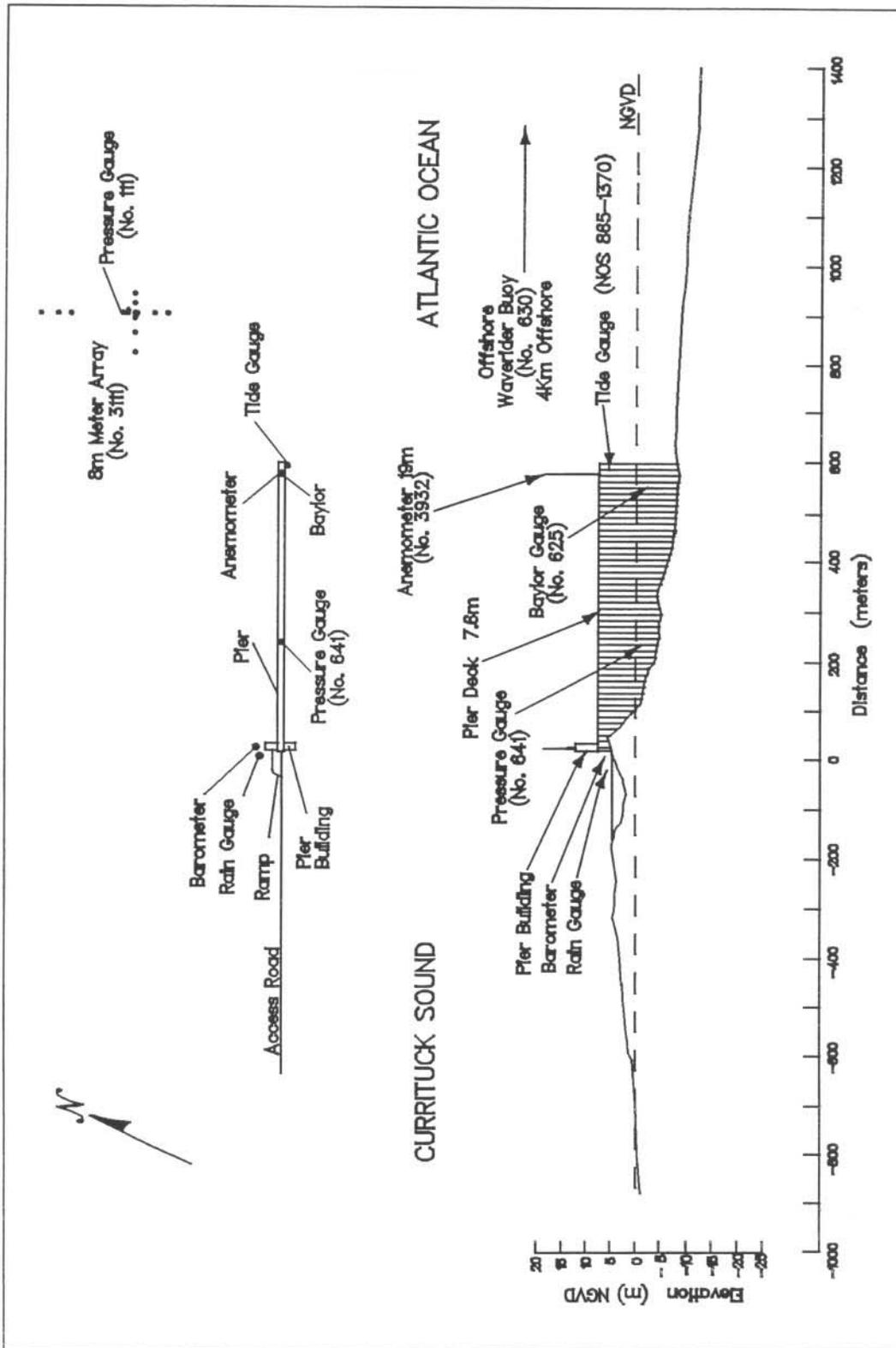


Figure 3. Instrument Locations, Elevations From NGVD

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -
 $\text{m/s} \times 1.943 = \text{kn}$

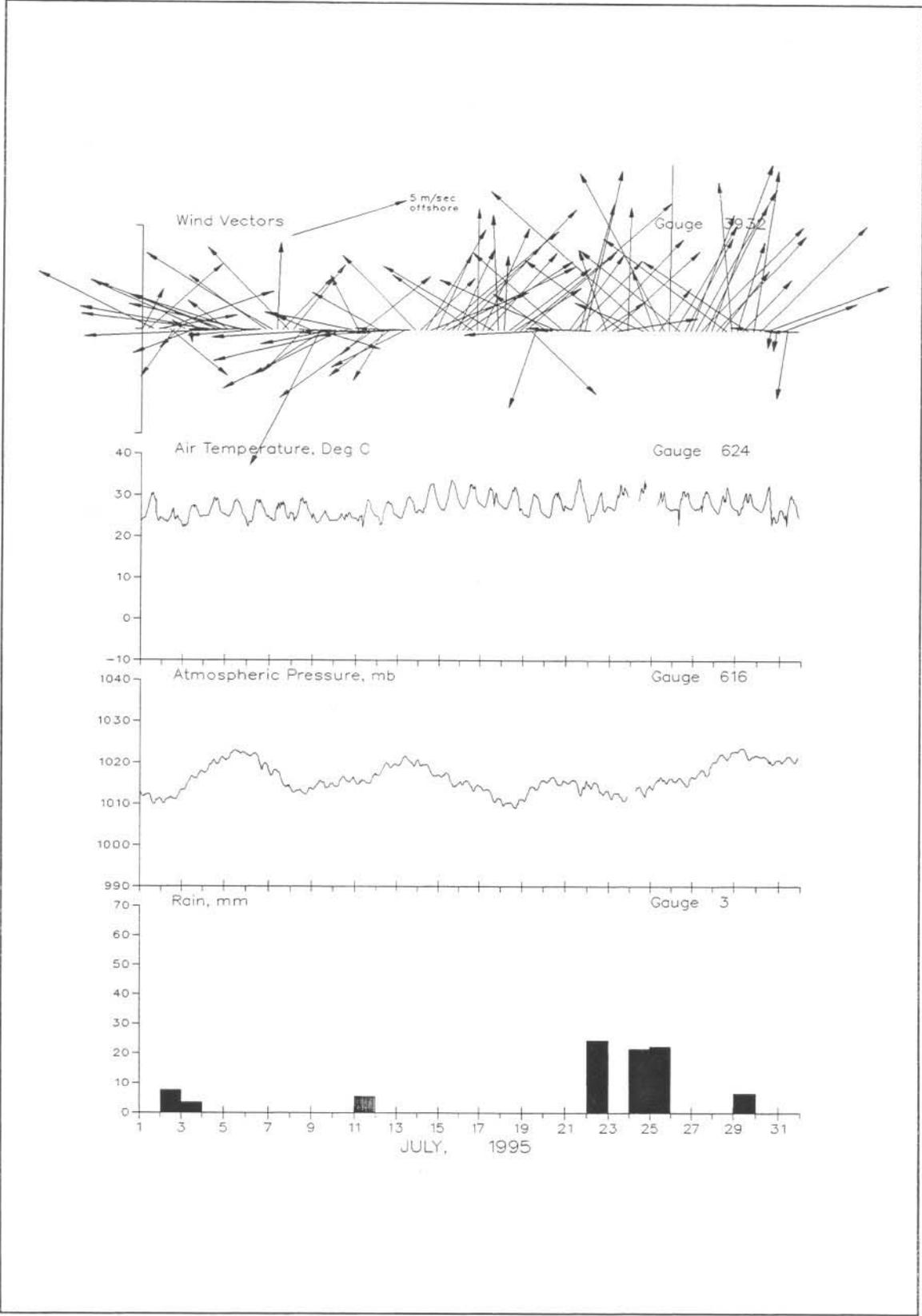


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Jul 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	2	203	23.7	1012.9	0
	700	4	224	26.4	1012.3	0
	1300	5	120	30.0	1011.1	0
	1900	3	258	23.7	1010.9	0
2	100	5	247	24.3	1010.8	0
	700	3	312	23.7	1011.2	7
	1300	3	31	26.5	1011.3	0
	1900	1	43	24.0	1011.8	0
3	100	1	126	22.9	1013.5	0
	700	1	351	25.2	1015.3	4
	1300	3	65	26.9	1016.4	0
	1900	5	117	25.1	1017.0	0
4	100	5	101	24.9	1017.6	0
	700	5	97	26.3	1018.9	0
	1300	4	114	28.7	1020.6	0
	1900	6	113	25.9	1020.3	0
5	100	2	129	25.1	1021.0	0
	700	6	86	25.8	1021.7	0
	1300	5	110	28.9	1022.9	0
	1900	5	104	25.6	1022.1	0
6	100	0		22.4	1021.9	0
	700	3	89	25.8	1022.0	0
	1300	3	83	28.1	1021.4	0
	1900	4	129	25.7	1019.7	0
7	100	6	125	24.2	1017.5	0
	700	4	181	26.4	1018.3	0
	1300	3	219	27.5	1016.6	0
	1900	5	140	24.7	1014.1	0
8	100	4	213	25.3	1013.6	0
	700	3	272	25.7	1013.2	0
	1300	3	39	28.8	1012.9	0
	1900	2	115	26.2	1012.8	0
9	100	3	288	25.0	1013.5	0
	700	7	23	23.7	1014.9	0
	1300	4	53	25.9	1015.3	0
	1900	5	85	23.9	1014.2	0
10	100	3	76	23.9	1014.3	0
	700	6	59	25.1	1015.2	0
	1300	6	74	25.5	1016.1	0
	1900	4	102	24.6	1015.6	0

Table 3
Meteorological Data (continued)

Jul 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	3	156	24.0	1015.3	0
	700	4	227	22.6	1015.6	5
	1300	2	43	29.1	1015.1	0
	1900	5	49	25.9	1015.9	0
12	100	3	122	24.9	1017.1	0
	700	3	27	26.0	1018.3	0
	1300	3	48	28.5	1019.8	0
	1900	4	87	25.5	1019.2	0
13	100	3	85	24.7	1019.5	0
	700	4	59	26.4	1021.0	0
	1300	2	91	29.6	1021.0	0
	1900	5	139	26.6	1019.6	0
14	100	3	222	26.5	1020.8	0
	700	5	207	27.1	1019.5	0
	1300	4	245	32.1	1019.1	0
	1900	4	201	30.2	1016.8	0
15	100	7	225	26.9	1017.0	0
	700	6	239	27.5	1017.0	0
	1300	6	222	33.2	1016.1	0
	1900	4	201	30.9	1014.2	0
16	100	7	218	27.5	1015.3	0
	700	5	232	28.0	1015.5	0
	1300	4	128	32.7	1014.8	0
	1900	6	180	30.0	1013.6	0
17	100	5	201	27.7	1014.3	0
	700	5	216	28.3	1013.5	0
	1300	6	123	31.5	1012.8	0
	1900	6	177	29.2	1010.6	0
18	100	4	182	27.1	1010.6	0
	700	4	227	28.0	1010.3	0
	1300	3	232	31.1	1009.9	0
	1900	9	225	27.9	1010.3	0
19	100	5	223	25.4	1011.2	0
	700	4	318	25.9	1012.6	0
	1300	4	16	30.1	1014.1	0
	1900	3	85	26.5	1014.7	0
20	100	3	128	25.3	1015.7	0
	700	1	95	26.4	1016.3	0
	1300	6	116	30.6	1015.7	0
	1900	5	135	27.1	1014.7	0

Table 3
Meteorological Data (concluded)

Jul 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	4	211	27.1	1015.4	0
	700	4	219	27.7	1015.9	0
	1300	6	192	33.7	1015.0	0
	1900	8	190	28.8	1013.9	0
22	100	3	92	23.6	1014.6	0
	700	6	219	26.1	1015.2	24
	1300	2	232	30.4	1013.6	0
	1900	4	163	26.8	1012.5	0
23	100	5	223	27.2	1012.1	0
	700	3	259	28.5	1012.8	0
	1300	5	130	31.8	1011.8	0
	1900	6	181	30.9	1011.0	0
24	100		Hardware Error			0
	700	5	236	inoperative	1013.3	22
	1300	3	115	30.9	1013.7	0
	1900	9	135		1013.1	0
25	100	3	162	inoperative	1013.9	0
	700	2	212		1015.7	23
	1300	8	154	29.5	1016.1	0
	1900	9	180	27.0	1015.1	0
26	100	6	207	26.9	1016.3	0
	700	6	132	22.9	1015.8	0
	1300	5	203	31.3	1015.6	0
	1900	6	197	28.9	1014.6	0
27	100	8	205	26.9	1016.6	0
	700	7	219	27.2	1017.5	0
	1300	7	202	30.8	1018.2	0
	1900	8	197	28.8	1017.4	0
28	100	6	218	26.6	1020.3	0
	700	3	212	28.0	1021.6	0
	1300	7	130	28.8	1021.6	0
	1900	7	175	28.1	1021.5	0
29	100	4	193	26.7	1022.8	0
	700	3	217	27.4	1023.5	6
	1300	6	127	28.8	1022.4	0
	1900	8	186	28.1	1021.5	0
30	100	7	220	26.7	1021.8	0
	700	5	245	27.9	1021.7	0
	1300	1	9	30.5	1020.4	0
	1900	1	7	23.9	1019.9	0
31	100	3	245	26.7	1020.9	0
	700	3	7	22.8	1020.8	0
	1300	2	94	30.1	1021.5	0
	1900	1	89	25.9	1020.5	0
		Resultant		Mean	Mean	Total
		2	170	27.1	1016.3	91

3 Wave Data

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{m0} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{m0} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4
Wave Data**

Jul 1995										
Day	Hour	641		625		3111			630	
		Pressure Hmo,m	Gauge Tp,sec	Baylor Hmo,m	Gauge Tp,sec	8 Meter Array			Waverider	
						Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	0.33	9.9	0.59	9.9	0.62	9.8	72	0.73	9.2
	0700	0.35	5.5	0.52	8.9	0.57	8.9	68	0.61	9.2
	1300	0.32	5.7	0.50	8.3	0.52	8.9	82	0.60	7.4
	1900	0.33	6.5	0.43	8.9	0.45	6.6	88	0.57	8.6
2	0100	0.29	5.6	0.39	8.9	0.42	8.9	102	0.51	6.5
	0700	0.29	5.5	0.41	8.1	0.42	8.2	84	0.51	8.3
	1300	0.28	8.1	0.39	8.6	0.34	8.2	86	0.51	8.1
	1900	0.32	3.6	0.47	3.8	0.35	7.6	84	0.58	3.7
3	0100	0.22	7.8	0.31	7.6	0.29	7.6	88	0.41	7.8
	0700	0.22	6.6	0.31	7.8	0.31	7.1	88	0.41	7.4
	1300	0.21	7.0	0.28	7.0	0.28	7.1	90	0.38	7.4
	1900	0.29	5.7	0.45	2.8	0.33	6.6	88	0.52	6.6
4	0100	0.30	14.3	0.43	3.0	0.34	7.6	88	0.54	3.3
	0700	0.28	6.5	0.41	3.0	0.32	13.6	86	0.52	2.9
	1300	0.28	14.3	0.37	14.3	0.34	13.6	86	0.49	4.1
	1900	0.39	4.5	0.52	4.6	0.44	4.8	108	0.68	4.2
5	0100	0.41	4.9	0.51	5.1	0.48	4.8	130	0.65	5.0
	0700	0.33	4.6	0.48	4.7	0.42	4.6	130	0.56	4.8
	1300	0.36	4.2	0.49	4.4	0.41	4.6	78	0.59	4.4
	1900	0.38	5.0	0.52	4.9	0.49	5.0	86	0.65	5.0
6	0100	0.52	5.6	0.52	5.5	0.56	5.6	120	0.71	5.2
	0700	0.43	5.7	0.53	5.5	0.56	5.6	118	0.67	5.7
	1300	0.46	5.6	0.50	5.6	0.53	5.3	100	0.64	5.5
	1900	0.39	5.7	0.51	5.6	0.49	5.6	108	0.61	5.4
7	0100	0.44	5.3	0.53	5.5	0.56	6.2	114	0.70	7.0
	0700	0.52	7.0	0.60	6.5	0.67	6.2	114	0.82	6.0
	1300	0.58	6.5	0.64	6.8	0.68	8.9	90	0.77	5.4
	1900	0.58	9.5	0.63	9.5	0.69	8.9	106	0.82	9.5
8	0100	0.61	7.6	0.62	7.6	0.67	7.6	106	0.80	8.1
	0700	0.48	8.9	0.51	8.6	0.57	8.9	108	0.64	8.3
	1300	0.54	7.4	0.57	13.5	0.64	8.9	104	0.67	8.1
	1900	0.48	8.3	0.55	8.3	0.56	8.2	100	0.67	8.3
9	0100	0.39	12.2	0.47	13.5	0.52	13.6	106	0.56	13.5
	0700	0.76	5.3	0.94	5.3	1.00	5.0	28	1.14	5.2
	1300	0.52	5.1	0.67	5.5	0.71	5.3	58	0.98	5.0
	1900	0.40	12.9	0.55	11.2	0.50	13.6	88	0.64	11.2
10	0100	0.35	12.2	0.52	11.7	0.50	12.0	76	0.58	10.3
	0700	0.37	10.7	0.53	10.7	0.48	10.8	64	0.61	10.3
	1300	0.44	3.8	0.63	3.7	0.60	3.8	100	0.72	3.7
	1900	0.38	11.2	0.53	11.7	0.51	12.0	70	0.61	3.9

Table 4
Wave Data (continued)

Jul 1995										
Day	Hour	641		625		3111			630	
		Pressure Hmo,m	Gauge Tp,sec	Baylor Hmo,m	Gauge Tp,sec	8 Meter Array Hmo,m Tp,sec		Dir,TN	Waverider Hmo,m	Tp,sec
11	0100	0.31	11.7	0.47	11.2	0.46	10.8	72	0.56	10.7
	0700	0.31	11.2	0.42	12.9	0.42	12.0	72	0.51	9.9
	1300	0.28	10.7	0.37	10.3	0.42	10.8	78	0.48	10.7
	1900	0.39	10.3	0.44	10.7	0.44	10.8	76	0.53	10.7
12	0100	0.30	6.6	0.38	10.7	0.41	10.8	84	0.47	11.7
	0700	0.35	6.5	0.37	10.7	0.41	10.8	78	0.51	6.3
	1300	0.35	6.5	0.43	10.7	0.44	10.8	88	0.52	10.7
	1900	0.40	10.7	0.45	10.7	0.45	10.8	106	0.55	10.3
13	0100	0.36	6.5	0.42	10.7	0.45	10.8	70	0.59	10.7
	0700	0.37	10.3	0.43	10.3	0.41	10.8	90	0.54	10.7
	1300	0.33	10.3	0.41	10.3	0.41	9.8	90	0.57	10.3
	1900	0.39	9.5	0.44	10.3	0.42	10.8	66	0.58	6.3
14	0100	0.27	10.7	0.31	10.3	0.35	10.8	68	0.47	10.3
	0700	0.28	9.9	0.31	10.3	0.34	10.8	72	0.43	9.9
	1300	0.24	10.3	0.27	10.3	0.30	9.8	84	0.38	10.7
	1900	0.34	9.9	0.35	10.3	0.40	9.8	94	0.54	10.3
15	0100	0.26	10.7	0.29	9.9	0.32	9.8	74	0.42	10.3
	0700	0.30	9.9	0.32	10.3	0.37	12.0	104	0.42	12.2
	1300	0.44	11.7	0.48	11.7	0.50	10.8	106	0.60	11.7
	1900	0.76	10.7	0.65	10.7	0.72	10.8	100	0.82	11.2
16	0100	0.65	11.7	0.64	11.2	0.70	12.0	102	0.76	11.7
	0700	0.62	11.2	0.63	11.2	0.66	10.8	104	0.76	11.2
	1300	0.66	10.7	0.58	10.7	0.59	10.8	106	0.70	10.7
	1900	0.53	9.9	0.51	9.5	0.60	9.8	106	0.71	9.2
17	0100	0.60	9.9	0.61	9.9	0.67	10.8	104	0.79	10.7
	0700	0.63	10.7	0.68	10.7	0.76	10.8	108	0.82	10.7
	1300	0.64	10.7	0.60	10.7	0.64	10.8	104	0.73	11.2
	1900	0.72	12.2	0.69	12.2	0.75	12.0	106	0.89	12.2
18	0100	0.82	11.7	0.73	12.2	0.75	12.0	102	0.99	11.2
	0700	0.76	11.2	0.77	11.7	0.83	12.0	102	0.91	12.2
	1300	0.72	11.2	0.63	10.3	0.66	10.8	108	0.78	11.7
	1900	0.54	10.7	0.54	10.7	0.57	10.8	104	0.69	11.2
19	0100	0.49	10.3	0.46	10.3	0.48	10.8	74	0.60	11.2
	0700	0.31	9.9	0.37	9.9	0.37	9.8	104	0.47	9.9
	1300	0.35	9.2	0.45	9.2	0.45	8.9	106	0.56	9.2
	1900	0.38	8.6	0.44	8.3	0.43	8.2	104	0.57	8.3
20	0100	0.38	8.1	0.40	7.4	0.43	7.6	106	0.55	8.3
	0700	0.31	7.6	0.38	7.4	0.40	7.1	106	0.53	8.1
	1300	0.34	9.5	0.36	9.9	0.43	9.8	92	0.48	9.5
	1900	0.37	8.6	0.48	9.2	0.45	8.2	76	0.62	7.6

Table 4
Wave Data (concluded)

Jul 1995										
Day	Hour	641		625		3111			630	
		Pressure Hmo,m	Gauge Tp,sec	BayLor Hmo,m	Gauge Tp,sec	8 Meter Array Hmo,m Tp,sec		Dir,TN	Waverider Hmo,m	Tp,sec
21	0100	0.37	7.4	0.42	10.3	0.46	13.6	64	0.57	12.9
	0700	0.33	7.8	0.39	12.9	0.46	12.0	64	0.54	12.2
	1300	0.44	8.6	0.43	11.7	0.51	12.0	66	0.56	11.7
	1900	0.42	7.8	0.48	11.7	0.50	12.0	68	0.69	11.2
22	0100	0.51	7.4	0.61	3.5	0.61	12.0	64	0.69	11.2
	0700	0.37	7.2	0.46	11.2	0.47	12.0	68	0.55	11.2
	1300	0.39	6.6	0.42	10.7	0.46	10.8	64	0.54	10.7
	1900	0.37	7.0	0.43	11.7	0.45	12.0	68	0.53	11.2
23	0100	0.41	7.2	0.44	11.2	0.48	10.8	84	0.60	10.7
	0700	0.40	12.9	0.43	10.3	0.45	12.0	68	0.54	10.3
	1300	0.41	12.2	0.41	9.9	0.47	9.8	68	0.55	10.7
	1900	0.39	9.9	0.41	9.9	0.46	9.8	104	0.57	9.5
24	0100				Harware Error					
	0700	0.43	10.2	0.46	9.1	Inoperative			0.60	9.5
	1300	0.45	10.7	0.49	8.6	0.52	8.9	80	0.61	9.5
	1900	0.43	9.2	0.46	9.2	0.53	8.9	82	0.74	9.2
25	0100	0.50	7.0	0.56	8.6	0.62	7.6	106	0.77	6.3
	0700	0.52	6.8	0.53	10.7	0.58	5.9	122	0.76	6.0
	1300	0.51	8.1	0.55	8.1	0.56	7.6	90	0.74	8.1
	1900	0.51	7.4	0.53	7.8	0.53	7.1	108	0.76	4.7
26	0100	0.44	8.1	0.45	8.3	0.49	9.8	90	0.71	4.6
	0700	0.56	8.1	0.54	5.2	0.59	5.6	120	0.82	5.4
	1300	0.44	9.5	0.48	8.6	0.53	9.8	86	0.72	7.6
	1900	0.46	7.0	0.47	9.9	0.55	9.8	82	0.70	7.2
27	0100	0.46	7.4	0.48	9.9	0.53	7.1	110	0.71	7.4
	0700	0.47	7.2	0.46	8.1	0.50	7.1	110	0.67	6.6
	1300	0.40	6.8	0.45	10.7	0.46	10.8	80	0.64	10.7
	1900	0.49	5.9	0.49	9.2	0.56	10.8	82	0.73	5.6
28	0100	0.38	5.6	0.41	9.9	0.44	10.8	94	0.58	10.7
	0700	0.41	10.7	0.41	10.7	0.46	10.8	92	0.60	5.4
	1300	0.38	10.3	0.43	9.9	0.43	9.8	104	0.64	10.3
	1900	0.45	9.9	0.46	10.3	0.51	9.8	104	0.67	9.5
29	0100	0.36	10.3	0.41	10.3	0.44	10.8	102	0.60	10.3
	0700	0.46	10.3	0.49	10.7	0.54	10.8	102	0.69	4.3
	1300	0.42	5.6	0.45	9.9	0.49	9.8	102	0.65	9.5
	1900	0.53	9.5	0.54	9.9	0.59	8.9	86	0.77	9.5
30	0100	0.49	8.9	0.53	8.9	0.56	9.8	80	0.72	8.9
	0700	0.49	9.5	0.51	9.9	0.54	9.8	108	0.71	9.5
	1300	0.45	9.2	0.48	9.2	0.54	8.9	106	0.64	8.9
	1900	0.65	9.2	0.56	8.6	0.59	8.9	106	0.75	9.5
31	0100	0.53	10.3	0.51	10.7	0.56	10.8	102	0.71	9.2
	0700	0.59	9.2	0.56	9.5	0.60	9.8	106	0.72	9.5
	1300	0.57	9.9	0.54	9.9	0.64	9.8	108	0.73	9.5
	1900	0.62	9.2	0.69	9.2	0.68	8.9	106	0.76	9.2
	Mean	0.43	8.6	0.49	9.2	0.51	9.4	90	0.64	8.7
	Std dev	0.13	2.3	0.11	2.4	0.12	2.2	19	0.13	2.5

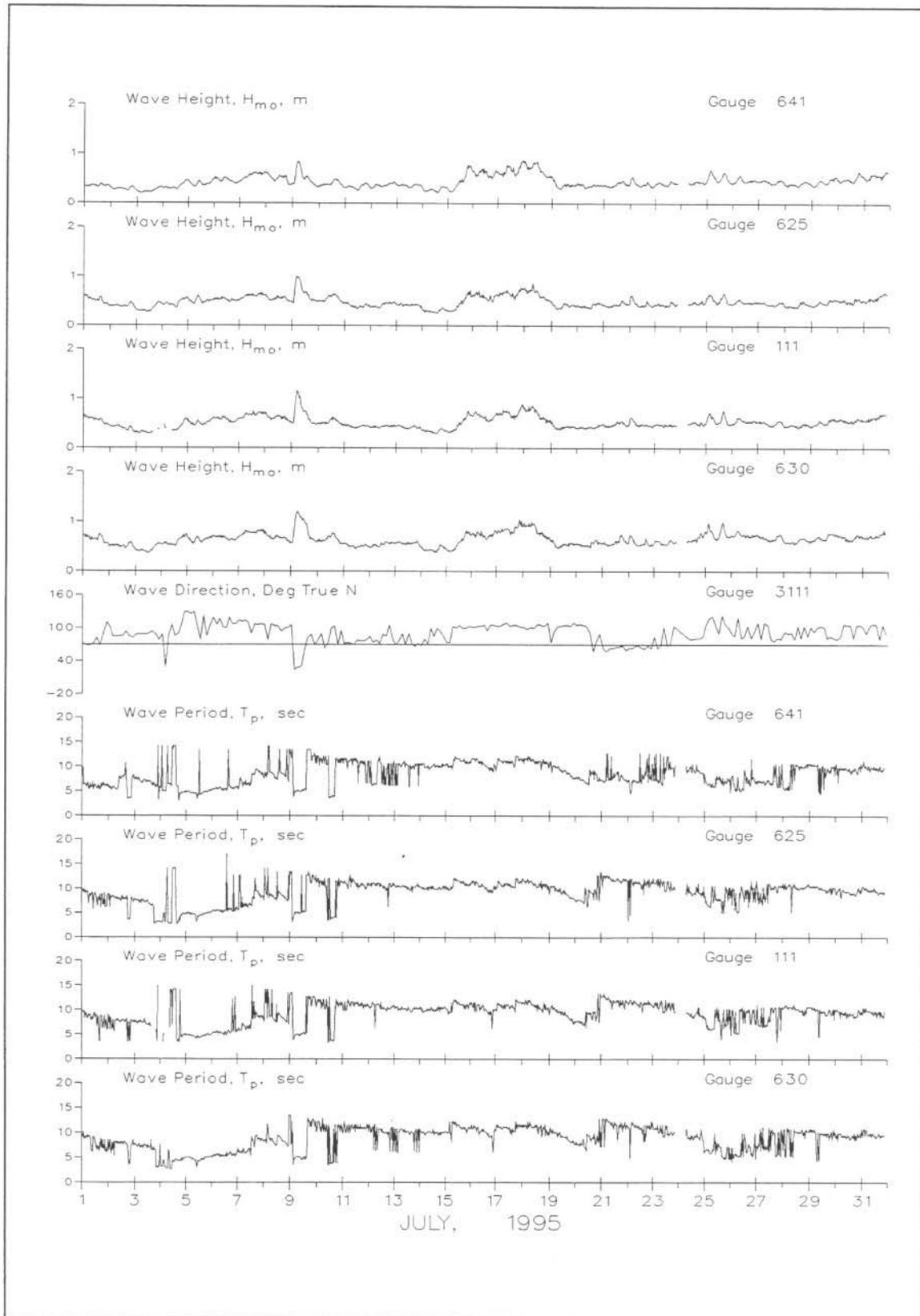


Figure 5. Wave Heights and Periods

4 Current Data

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

JULY 1995																	
Cross Long					Cross Long					Cross Long							
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100	2	-1	3	289	1300	1	-1	3	307	22	100	5	2	5	223	
	700	3	-1	4	280	1900	3	2	4	214		700	1	6	7	172	
	1300	-1	2	3	111	12	100	3	1	3	242		1300	0	0	0	
	1900	1	0	2	295		700	3	7	7	182		1900	1	2	3	185
2	100	3	-1	3	278		1300	1	4	4	180	23	100	4	1	4	239
	700	2	0	2	277		1900	4	1	4	242		700	1	3	3	182
	1300	-1	5	5	134	13	100	2	2	2	201		1300	4	0	4	251
	1900	0	-2	3	360		700	0	1	1	121		1900	-1	2	3	114
3	100	0	5	5	155		1300	0	0	0		24	100	0	-1	2	339
	700	0	2	2	156		1900	4	-2	5	289		700	0	5	5	157
	1300	1	1	2	193	14	100	3	1	3	230		1300		inoperative		
	1900	1	-3	4	329		700	5	0	5	262		1900	0	3	3	165
4	100	0	4	4	154		1300	3	1	3	223	25	100	-1	1	2	89
	700	2	0	2	258		1900	2	-3	5	311		700	1	3	4	179
	1300	2	4	4	191	15	100	3	1	3	225		1300	2	0	2	249
	1900	3	-1	3	281		700	4	-1	4	279		1900	3	-1	4	279
5	100	4	2	4	221		1300	2	2	3	199	26	100	3	-3	5	302
	700	1	-1	2	306		1900	4	-3	5	294		700	4	2	4	221
	1300	3	2	3	218	16	100	5	6	8	199		1300	3	0	3	273
	1900	2	-1	3	292		700	4	1	4	232		1900	2	1	2	236
6	100	3	1	4	238		1300	0	7	7	149	27	100	4	-3	6	297
	700	0	0	0			1900		inoperative				700	4	3	5	213
	1300	1	2	2	188	17	100	-1	1	3	101		1300	1	2	2	195
	1900	1	2	3	189		700	2	0	2	283		1900	2	0	2	249
7	100	2	2	3	213		1300	1	3	4	176	28	100	3	-2	4	292
	700	2	2	2	208		1900	2	1	2	210		700	1	1	2	209
	1300	2	1	2	242	18	100	2	2	3	204		1300	3	3	4	201
	1900	2	1	3	223		700	3	-1	4	275		1900	2	0	3	276
8	100	3	-3	5	306		1300	8	2	9	235	29	100	3	0	3	268
	700	4	1	4	236		1900	1	4	4	176		700	2	2	3	213
	1300	1	-1	2	321	19	100	2	6	6	180		1300	1	3	3	186
	1900	5	3	6	215		700	0	1	2	171		1900	2	-1	3	296
9	100	3	0	3	249		1300	7	7	10	206	30	100	4	-1	4	261
	700	2	9	9	173		1900	0	4	5	151		700	3	0	4	273
	1300	4	13	13	176	20	100	0	3	3	151		1300	1	5	5	172
	1900	7	6	9	207		700	0	-1	2	359		1900	4	1	4	236
10	100	2	-1	2	289		1300	3	3	4	204	31	100	1	6	6	174
	700	0	4	4	143		1900	0	2	2	129		700	-1	2	3	123
	1300	-1	-1	2	20	21	100	3	-3	5	304		1300	2	11	11	171
	1900	3	0	3	245		700	2	1	2	216		1900	0	2	2	159
11	100	1	-2	3	316		1300	5	-1	6	272						
	700	2	6	7	181		1900	4	4	6	207						

KEY:
 +cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Jul 1995												
Pier End				Mid-Surf Zone				Beach				
Day	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	20	-5	20	55	26	-44	51	11	South	13	S	
2	-2	18	19	166	4	-7	8	9	South	3	S	
3	0	13	13	160	0	-9	9	340	South	15	N	
4	0	-25	25	340	9	-47	48	351	South	12	N	
5	-4	-18	18	326	-1	-9	9	334	South	17	N	
6	-3	-23	23	331	1	-3	4	2	South	41	N	
7	7	-17	19	2	-2	-15	15	334	South	55	N	
8	15	10	18	104	19	7	20	90	no observation			
9	-4	38	38	166	2	41	41	157	North	43	S	
10	-3	23	23	169	0	-19	19	340	North	14	S	
11	12	9	15	106	24	-44	50	9	South	8	N	
12	-11	10	15	208	-3	-14	14	329	South	32	N	
13	-9	-15	17	309	5	-12	13	2	South	25	N	
14	11	-27	29	2	6	-11	12	9	South	10	N	
15	17	-9	19	43	10	-38	39	354	South	11	N	
16	16	16	22	115	17	-68	70	354	no observation			
17	7	5	9	106	2	-36	36	343	South	102	N	
18	3	-9	9	357	4	-87	87	343	South	107	N	
19	4	14	14	143	4	10	11	141	South	3	N	
20	0	41	41	160	10	-10	14	26	South	13	S	
21	13	-15	20	20	7	-4	8	40	South	22	N	
22	-20	-41	45	313	7	-12	14	11	South	0		
23	0	-19	19	340	6	-11	12	7	South	14	N	
24	5	-5	7	30	10	-10	14	25	South	14	N	
25	0	8	8	160	9	-12	15	17	South	27	N	
26	3	-9	9	359	6	-18	20	359	South	28	N	
27	11	-16	19	15	5	-16	16	357	South	26	N	
28	8	-19	21	2	8	-15	17	9	South	17	N	
29	11	-5	12	45	7	-15	16	4	South	23	N	
30	10	10	13	115	4	-18	19	351	South	26	N	
31	-8	12	14	195	11	7	13	104	South	52	N	

KEY:
+cross-shore = offshore, cm/sec
-cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec

5 Visual Observations

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Jul 1995								
Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0645	95	65		12	23.6	1.0219	2.4
2	0835	95	15		5	23.6	1.0224	4.0
3	0620	85			3	24.4	1.0218	4.6
4	0705	100	150		15	25.8	1.0181	3.7
5	0615	95	75		34	25.0	1.0212	5.5
6	0617	90	120		43	23.6	1.0223	3.7
7	0615	95	80		40	23.3	1.0232	2.4
8	0800	110	979		47	22.8	1.0232	4.0
9	0755	30	65		67	23.9	1.0231	4.3
10	0615	60	100		12	25.8	1.0182	2.7
11	0615	110	0		11	25.3	1.0211	4.9
12	0610	90	60		6	26.1	1.0202	4.6
13	0615	40	75		8	26.4	1.0201	5.2
14	0610	100	75		11	26.4	1.0205	4.0
15	0625	100	145		5	23.6	1.0231	3.7
16	0620	100	80		46	20.6	1.0243	2.4
17	0635	90	155		52	24.4	1.0229	4.6
18	0615	90	140		43	25.3	1.0235	4.6
19	0610	95	350		30	21.9	1.0239	3.7
20	0620	100			30	26.1	1.0201	5.5
21	0600	95	80		15	24.4	1.0228	4.9
22	1030	85			32	24.2	1.0231	6.7
23	1105	100			29	24.4	1.0232	6.7
24	0635	80	110		16	21.7	1.0239	5.5
25	0605	95	140		23	21.4	1.0241	6.1
26	0610	85			9	19.4	1.0246	2.7
27	0610	100	140		12	18.3	1.0242	3.0
28	0610	105			11	18.1	1.0242	3.7
29	0720	105	90		15	17.5	1.0252	3.0
30	0740	110			27	16.7	1.0254	2.4
31	0615	85			37	18.6	1.0247	3.0

6 Water Levels

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

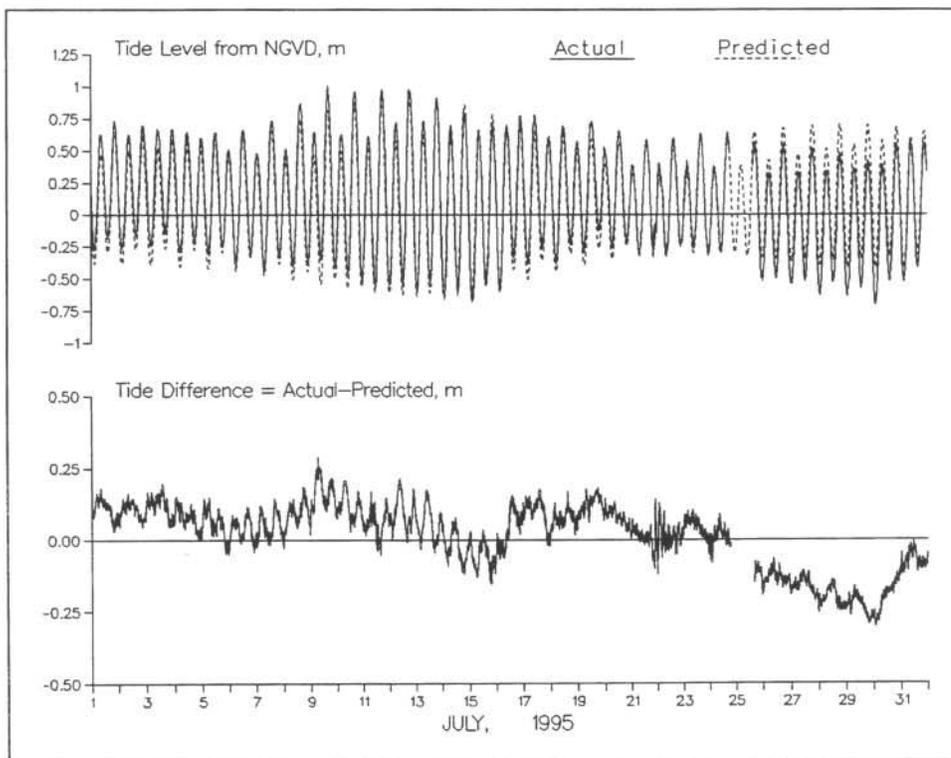


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

JUL 1995 Tide Levels															
Day	High		Day	Low		Mean Range		Day	High		Day	Low		Mean Range	
	Time	m		Time	m	m	m		Time	m		Time	m	m	m
1	0900	0.63	1	0300	-0.28	0.18	0.91	16	2224	0.77	16	1636	-0.34	0.21	1.11
1	2130	0.73	1	1500	-0.19	0.25	0.92	17	1124	0.78	17	0436	-0.39	0.20	1.17
2	1000	0.63	2	0336	-0.27	0.18	0.89	17	2342	0.61	17	1736	-0.27	0.17	0.88
2	2218	0.70	2	1554	-0.17	0.26	0.87	18	1142	0.69	18	0606	-0.39	0.17	1.08
3	1012	0.67	3	0454	-0.25	0.21	0.92	19	0024	0.57	18	1824	-0.25	0.17	0.82
3	2230	0.67	3	1630	-0.15	0.25	0.82	19	1318	0.73	19	0606	-0.30	0.24	1.03
4	1142	0.64	4	0530	-0.30	0.16	0.94	20	0030	0.53	19	1924	-0.14	0.19	0.67
5	0018	0.60	4	1818	-0.23	0.19	0.83	20	1342	0.66	20	0718	-0.26	0.20	0.92
5	1212	0.64	5	0554	-0.31	0.16	0.95	21	0124	0.39	20	2042	-0.22	0.09	0.61
6	0054	0.51	5	1824	-0.26	0.12	0.77	21	1436	0.59	21	0754	-0.32	0.13	0.91
6	1342	0.66	6	0636	-0.40	0.15	1.06	22	0218	0.40	21	2054	-0.34	0.05	0.74
7	0154	0.48	6	1948	-0.32	0.10	0.81	22	1506	0.60	22	0854	-0.33	0.14	0.93
7	1500	0.73	7	0718	-0.44	0.16	1.18	23	0354	0.42	22	2148	-0.24	0.08	0.66
8	0242	0.51	7	2054	-0.35	0.09	0.86	23	1700	0.63	23	0948	-0.27	0.18	0.90
8	1548	0.87	8	0848	-0.41	0.23	1.28	24	0418	0.38	23	2300	-0.33	0.03	0.71
9	0412	0.64	8	2154	-0.37	0.15	1.01	24	1712		24	1030	No data	this cycle	
9	1606	1.00	9	1000	-0.36	0.31	1.36	25	536		24	2354	No data	this cycle	
10	0448	0.63	9	2236	-0.41	0.13	1.04	25	1800		25	1124	No data	this cycle	
10	1754	0.96	10	1100	-0.47	0.25	1.42	26	0654	0.33	26	0030	-0.53	-0.09	0.85
11	0542	0.61	10	2354	-0.53	0.07	1.14	26	1848	0.55	26	1148	-0.50	0.02	1.05
11	1812	0.98	11	1224	-0.58	0.19	1.56	27	0730	0.33	27	0112	-0.54	-0.10	0.88
12	0654	0.72	12	0036	-0.55	0.10	1.27	27	1906	0.52	27	1254	-0.52	0.00	1.04
12	1848	0.98	12	1248	-0.54	0.23	1.52	28	0730	0.34	28	0148	-0.63	-0.14	0.97
13	0748	0.73	13	0142	-0.60	0.08	1.33	28	2000	0.48	28	1324	-0.53	-0.04	1.01
13	2024	0.91	13	1412	-0.52	0.19	1.44	29	0754	0.36	29	0218	-0.64	-0.14	1.00
14	0854	0.70	14	0242	-0.66	0.02	1.36	29	2024	0.42	29	1400	-0.58	-0.08	1.00
14	2042	0.79	14	1436	-0.63	0.10	1.42	30	0836	0.39	30	0242	-0.70	-0.15	1.09
15	0912	0.65	15	0312	-0.68	-0.01	1.33	30	2112	0.55	30	1500	-0.52	0.02	1.07
15	2142	0.71	15	1554	-0.55	0.07	1.27	31	0924	0.57	31	0312	-0.53	0.03	1.10
16	1018	0.70	16	0336	-0.60	0.07	1.30								

7 Bathymetry

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in June 1995 and the survey(s) in July 1995 on profile line 188, located 517 m south of the pier.

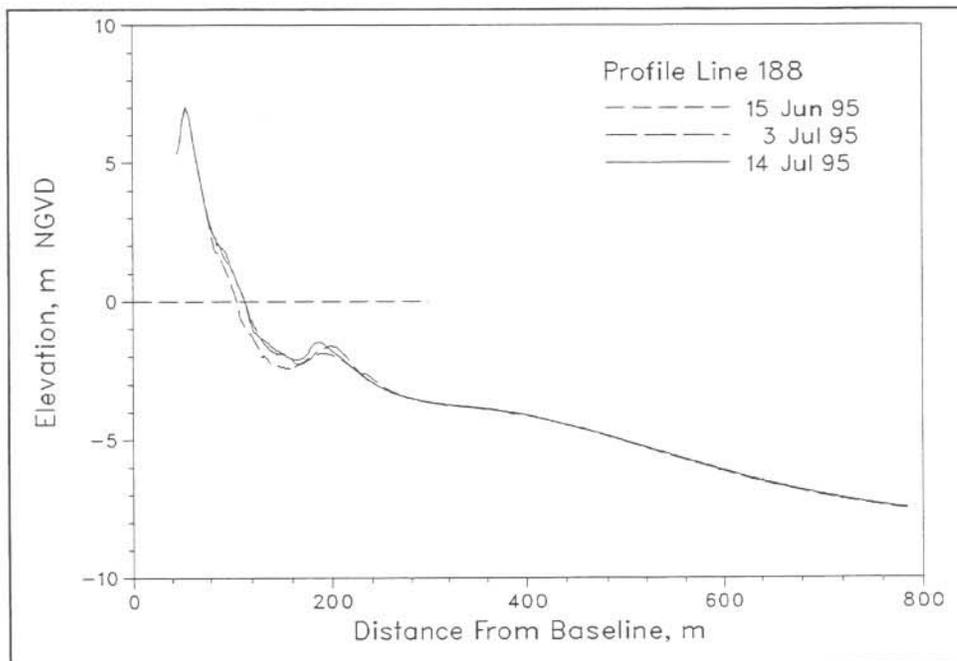


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1995. Cross-hatched areas indicate changes to the annual envelope which occurred in July.

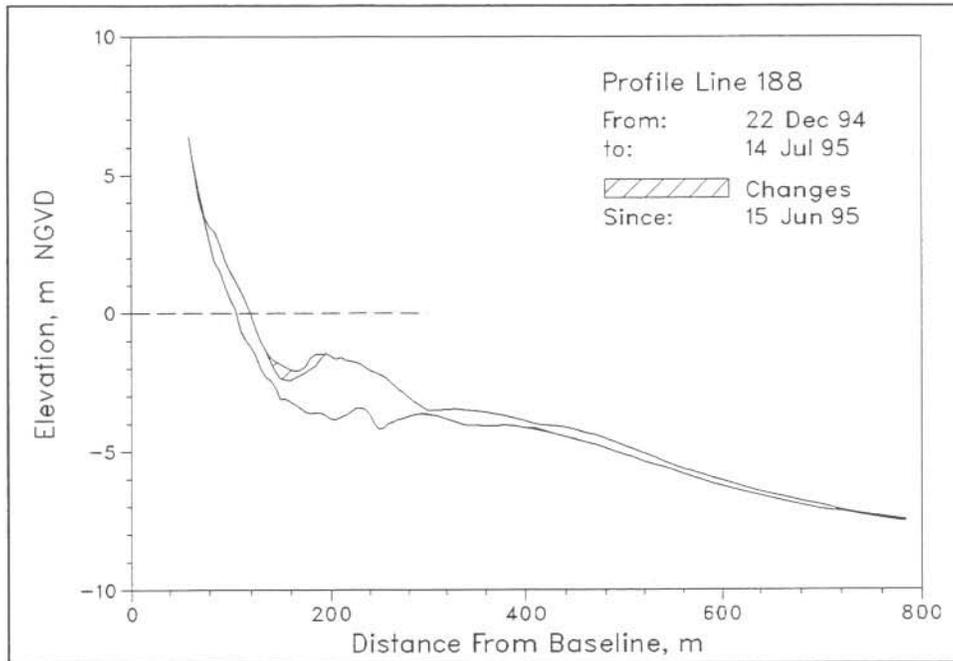


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 14 June. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

There was no bathymetric survey in July. Figure 9 is for reference only.

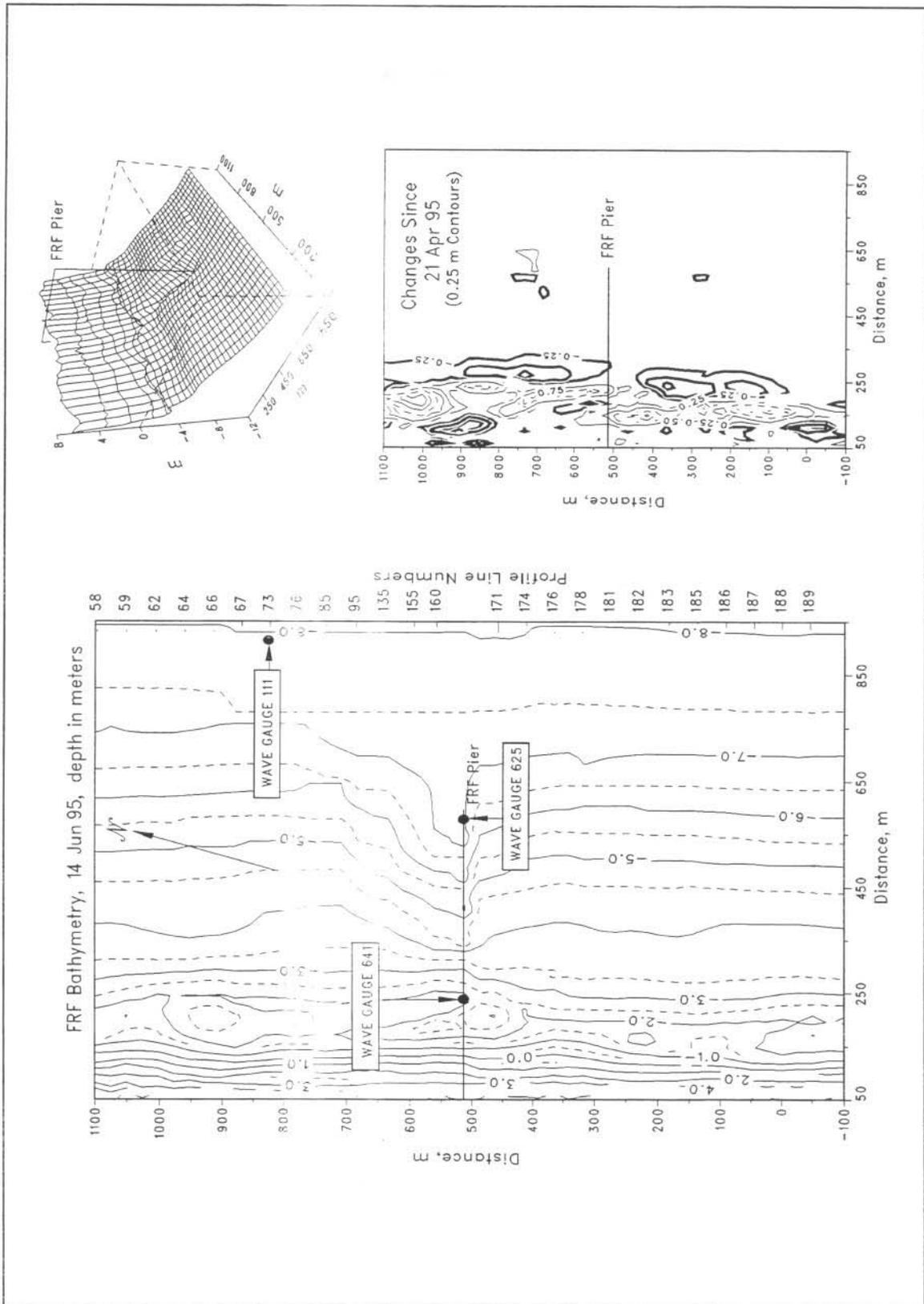


Figure 9. FRF Bathymetry, Depths Relative to NGVD

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge	U.S. Geological Survey
USACE-OCE	U.S. Library of Congress
USACE-SAD	U.S. National Park Service
USACE-NAP	U.S. National Weather Service
USACE-SAW	U.S. Naval Academy
USACE-WES	U.S. Naval Civil Eng. Lab
NAVSAC	U.S. Naval Oceanographic Off.
NOAA/NOS/OMS	U.S. Naval Research Lab
National Marine Fisheries	

Colleges/Universities:

Bucknell University	Scripps Institution of Oceanography
California Inst. of Tech.	Stockton State College
Duke Marine Lab	University Calif-Berkeley
East Carolina University	University of Florida
Florida Inst. of Tech.	University of Maryland-College Park
M.I.T.	University of Maryland-Baltimore
Naval Post Graduate School	University of North Carolina
NC State University	University of N C-Seagrant Program
Old Dominion University	University of Virginia
Oregon State University	Va. Inst. of Marine Science
Prince George's College	Rutgers University

Others:

Allied Signal Aerospace Co.	WCTI-TV
Applied Physics Lab	MEC Systems Corporation
Cape Hatteras Nat. Seashore	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	N.C. Div. Coastal Management
Coastal Science & Eng., Inc.	Oregon Inlet & Waterways Commis.
Dr. Cy Galvin	Raleigh-Durham Airport
GEOMET Tech., Inc.	Mr. Rowland
Mr. Hodges	Mr. Savage
Dr. Hylton	Science Application Int'l. Corp
Mr. Mason	Sherwood Industries
Mr. Rodgers	SEASUN Power Systems

Foreign:

Christchurch, Barbados
Ministry of Works, Bahamas
Dalhousie University, Halifax Nova Scotia
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)